FORSYTHE TALKS

VIOS MAINTENANCE

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AGENDA

- Best Practices Setup
- Network
- Installation
- Maintenance and Upgrades
- Backup and recovery
- Monitoring
- FBO
- Other
- Wrap-up/Questions

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BEST PRACTICES SETUP

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STAY CURRENT

VIOS Lifecycle

Version	GA	EOM	EOS/EOL
1.5	11/07	2008	09/11
2.1	11/08	2010	09/12
2.2.00	9/10	2011	09/13
2.2.1	10/11	10/12	04/15
2.2.2	10/12	10/13	09/16
2.2.3	4Q13		
2.2.4	2Q15		

Latest release:

2.2.3.3 FP27 SP03

- Basically AIX 6100-09-03 -
  - Requires NIM at 6100-09-03 or 7100-03-03
- Can be applied to 2.2.3.0, 2.2.3.1 or 2.2.3.2

Download updates from Fix Central:

http://www-933.ibm.com/support/fixcentral/

Download base from entitled software:

https://www-05.ibm.com/servers/eserver/ess/ProtectedServlet.wss

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USE FLRT AND CHECK PREREQS

FLRT Home Page:
http://www14.software.ibm.com/webapp/set2/flrt/home

VIOS to NIM Master Mapping:
http://www14.software.ibm.com/webapp/set2/sas/f/flrt/viostable.html

System Software Maps for VIOS:
http://www-01.ibm.com/support/docview.wss?uid=ssm1platformvios

AIX/VIOS Security Tables:
http://www14.software.ibm.com/webapp/set2/sas/f/flrt3/Sec_APARs.html

VIOS Hiper Tables:
http://www14.software.ibm.com/webapp/set2/flrt/doc?page=hiper#vios_hiper

Also check MPIO driver versions as there are specific requirements for each VIO release

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GENERAL

- Keep it simple
- Ensure LMB is the same on all servers if you want to use LPM
- Use hot pluggable adapters rather than built in ones
  - Easier maintenance
- Use dual VIO to allow for concurrent updates
- All adapters should be desired, not required
- Don't mix multipath drivers / HBAs
- Backup regularly – use NIM or scripts
- Run HMC Scanner and/or Sysplan before and after all changes
- Plan for at least one update per year (IBM normally puts out 2)
- Separate VIOs for production and non prod on large systems
- Test failover (SEA failover and disk if vio goes down)
- Use VIO commands wherever possible rather than going into oem_setup_env
- mirror vio rootvg
- Check errpt regularly
- NEVER run at 100% entitlement – ensure it is high enough and there are plenty of VPs and memory
- Run VIOS Advisor regularly
- NOTE – v2 requires at LEAST 30GB in rootvg

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PAGING

Clean up paging
By default VIO has a 512MB hd6 and a 1.5GB paging00 on the same LUN
Swapoff paging00 and delete it
Increase hd6 to 4GB
Reboot

Change from:

```
lsps -a
Page Space      Physical Volume   Volume Group Size     %Used Active  Auto  Type Chksum
paging00        hdisk0            rootvg        1024MB  18      yes     yes   lv   0
hd6             hdisk0            rootvg         512MB  35      yes     yes   lv   0
```

TO:

```
# lsps -a
Page Space      Physical Volume   Volume Group Size     %Used Active  Auto  Type Chksum
hd6             hdisk3            rootvg        4096MB  73      yes     yes   lv   0
```

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SETUP DUMP DEVICES AND LOGGING

Set up dump devices

```
sysdumpdev –e                to get correct size
mklv –y lv_dumplv1 rootvg 32 hdisk3
mklv –y lv_dumplv2 rootvg 32 hdisk2
sysdumpdev –P –p /dev/lv_dumplv1
sysdumpdev –P –s /dev/lv_dumplv2
rmlv  lg_dumplv
```

Logging

vi /etc/syslog.conf

```
user.info          /var/adm/lpm/lpm.log   rotate size 10m files 2 compress
user.debug         /var/adm/lpm/lpm.dbg   rotate size 20m files 8 compress
mail.debug         /usr/local/logs/mailog
*.emerg            /usr/local/logs/syslog
*.alert            /usr/local/logs/syslog
*.crit             /usr/local/logs/syslog
*.err              /usr/local/logs/syslog
auth.notice        /usr/local/logs/syslog
*.info             /usr/local/logs/messages

cd /usr/local/logs
touch syslog mailog infolog messages

stopsrc -s syslogd
startsrc -s syslogd
```

Try not to log to /var as bad things happen if it fills up
Make /usr/local/logs a new filesystem

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TUNING

- Make the same tuning changes you would make on AIX
- Set num_cmd_elems and max_xfer_size on the fiber adapters on VIO
  chdev -l fcs0 -a max_xfer_size=0x200000 -a num_cmd_elems=1024 -P
  chdev -l fcs1 -a max_xfer_size=0x200000 -a num_cmd_elems=1024 -P
- If NPIV also set on clients
- Client setting cannot be higher than the VIOs
- Pay attention to adapter layout and priorities

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ADAPTER TUNING

fcs0

bus_intr_lvl		115	Bus interrupt level	False	
bus_io_addr		0xdfc00	Bus I/O address	False	
bus_mem_addr	0xe8040000	Bus memory address		False	
init_link		al	INIT Link flags		True
intr_priority		3	Interrupt priority		False
lg_term_dma	0x800000	Long term DMA	True		
max_xfer_size	**(16MB DMA)**	**0x100000**	**Maximum Transfer Size**		**True**
num_cmd_elems		**200**	**Maximum number of COMMANDS to queue to the adapter True**		
pref_alpa		0x1	Preferred AL_PA		True
sw_fc_class		2	FC Class for Fabric		True

Changes I often make (test first)

max_xfer_size	***128MB DMA area for data I/O***	0x200000	Maximum Transfer Size	True
num_cmd_elems	1024	Maximum number of COMMANDS to queue to the adapter True		

Often I raise this to 2048 – check with your disk vendor

lg_term_dma is the DMA area for control I/O

Check these are ok with your disk vendor!!!

chdev -l fcs0 -a max_xfer_size=0x200000 -a num_cmd_elems=1024 -P
chdev -l fcs1 -a max_xfer_size=0x200000 -a num_cmd_elems=1024 -P

At AIX 6.1 TL2 VFCs will always use a 128MB DMA memory area even with default max_xfer_size

Remember make changes too both VIO servers and client LPARs if using NPIV
VIO server setting must be at least as large as the client setting

See Dan Braden Techdoc for more on tuning these:
http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/TD105745

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My VIO Server and NPIV Client Adapter Settings

VIO SERVER
#lsattr -El fcs0
lg_term_dma 0x800000 Long term DMA True
max_xfer_size 0x200000 Maximum Transfer Size True
num_cmd_elems 2048 Maximum number of COMMANDS to queue to the adapter True

NPIV Client (running at defaults before changes)
#lsattr -El fcs0
lg_term_dma 0x800000 Long term DMA True
max_xfer_size 0x200000 Maximum Transfer Size True
num_cmd_elems 2048 Maximum Number of COMMAND Elements True

NOTE NPIV client must be <= to settings on VIO

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Adapter Priorities affect Performance

Power 770 Layout		9117-MMC												
CEC		Top	123456 has GX cables			Bottom	2468ab			5877 pcie only I/O Drawer 123487				
	Slot	Desc	Pri	Alloc	Slot	Desc	Pri	Alloc	Slot	Desc	Pri	Alloc	IOC	
	C1	8GB DP fibre	1	lpar1	C1	8GB DP fibre	1	lpar1	C1	8GB DP fibre	1	vio1	1	
	C2	4PT 10/100/1000	3	lpar1	C2	4PT 10/100/1000	3	lpar1	C2	4PT 10/100/1000	3		1	
	C3	8GB DP fibre	5	vio2	C3	8GB DP fibre	5	vio1	C3		5		1	
	C4	4PT 10/100/1000	6	vio2	C4	4PT 10/100/1000	6	vio1	C4	8GB DP fibre	2	vio2	2	
	C5	8GB DP fibre	2	vio1	C5	8GB DP fibre	2	vio2	C5	4PT 10/100/1000	4		2	
	C6	4PT 10/100/1000	4	vio1	C6	4PT 10/100/1000	4	vio2	C6	4GB DP fibre	6	lpar1	2	
									C7	4GB DP fibre	7		3	
	D1	146GB disk		vio1	D1	146GB disk		vio1	C8		8		3	
	D4	146GB disk		vio2	D4	146GB disk		vio2	C9		9		3	
									C10		10		3	

Check the various Technical Overview Redbooks at http://www.redbooks.ibm.com/

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MEMORY PLANNING

Memory Planning Worksheet									
Power7 770							**This gives a rough estimate**		
							Assumes LMB size is 256MB		
Max RAM Capacity	**786432**	**Ram installed**	**393216**	**Ram Active**	**131072**		**Each active IVE port adds 102 MB**		
		GB	**384**		**LMB below in MB**				
Change the LMB size on this line to match MRO on HMC				**MB LMB =**	**256**	**Used the largest to show worst possible**			
		Extra high performance ports per VIO			**8**	**NPIV VFCs per VIO**	**12**		
LPAR	**Desired**	**Maximum**	**Ohead**	**OH/LMB**	**Roundup**	**Actual**	**Memory**	**Extra high If NPIV**	
NAME	**Memory**	**Memory**	**Max**	**MB**	**OH**	**Ohead (MB)**	**Needed**	**Perf ports**	
	MB	**MB**	**Div 64**		**MB**	**OH * LMB**			
VIOS1	3172	4096	64	0.25	1	256		4096	1680
VIOS2	3172	4096	64	0.25	1	256		4096	1680
LPAR1	12032	16384	256	1.00	1	256			
LPAR2	20224	24576	384	1.50	2	512			
LPAR3	14336	16384	256	1.00	1	256			
LPAR7	17152	17152	268	1.05	2	512			
LPAR8	65536	71680	1120	4.38	5	1280			
LPAR9	32768	36864	576	2.25	3	768			
HYPERVISOR						768			
IVE						102			
I/O drawer (I use 512 per 2)						512			
Safety Net						512			
							MB Total		
MB Total	**168392**	**191232**	**2988**	**11.671875**	**16**	**5990**	**174382**	**8192**	**3360**
GB Total	***164***					***5.85***	***170***	***8.00***	***3.28***
							GB Total		
Hypervisor requires 6GB minimum for overhead with these settings						**Add High Perf**		178	
LPARs require 164GB so the total active needed is at least 170GB						**Or add NPIV**		174	
Need to add NPIV and high speed adapter memory needs as well - could be 178GB									
Look at AME potential as well									
8GB and 10GB extra high performance adapters									
For each active port add 512MB									
If NPIV then 140MB per VFC adapter per client									
i.e. 20 ports per VIO without NPIV would be 20 * 512 = 10GB plus VIOS base for each VIOS									
if NPIV then we allocate per client so if there are 20 clients on each VIO then each									
VIO needs 20 * 140 = 2.8GB above the base									

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VIRTUAL ETHERNET

Link aggregation
- Put vio1 aggregate on a different switch to vio2 aggregate
- Provides redundancy without having to use NIB
- Allows full bandwidth and less network traffic (NIB is pingy)
- Basically SEA failover with full redundancy and bandwidth

Pay attention to entitlement
- VE performance scales by entitlement not VPs

If VIOS only handling network then disable network threading on the virtual Ethernet
- chdev –dev ent? thread=0

Turn on large send on VE adapters
- chdev –dev ent? –attr large_send=yes

Turn on large send on the SEA
- chdev –dev entx –attr largesend=1

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NETWORK

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STARTER SET OF TUNABLES NETWORK

Typically we set the following:

NETWORK
no -p -o rfc1323=1
no -p -o tcp_sendspace=262144
no -p -o tcp_recvspace=262144
no -p -o udp_sendspace=65536
no -p -o udp_recvspace=655360

Also check the actual NIC interfaces and make sure they are set to at least these values
You can't set udp_sendspace > 65536 as IP has an upper limit of 65536 bytes per packet

Check sb_max is at least 1040000 – increase as needed

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MY VIO SERVER SEA

```
# ifconfig -a
en6:
flags=1e080863,580<UP,BROADCAST,NOTRAILERS,RUNNING,SIMPLEX,MULTIC
AST,GROUPRT,64BIT,CHECKSUM_OFFLOAD(ACTIVE),CHAIN>

        inet  192.168.2.5   netmask 0xffffff00 broadcast 192.168.2.255
         tcp_sendspace 262144 tcp_recvspace 262144 rfc1323 1

lo0:
flags=e08084b,1c0<UP,BROADCAST,LOOPBACK,RUNNING,SIMPLEX,MULTICAST
,GROUPRT,64BIT,LARGESEND,CHAIN>
        inet 127.0.0.1 netmask 0xff000000 broadcast 127.255.255.255
        inet6 ::1%1/0
         tcp_sendspace 131072 tcp_recvspace 131072 rfc1323 1
```


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VALID ADAPTERS FOR P7 AND P7+

770

- Multifunction Cards – up to one per CEC
  - 1768 Integrated Multifunction Card with Copper SFP+ - Dual 10Gb copper and dual 10/100/1000MB copper ethernet
  - 1769 Integrated Multifunction Card with SR Optical - Dual 10Gb optical and dual 10/100/1000MB copper ethernet

PCIE Adapters

- 5284/5287 PCIE2 – 2 port 10GbE SR (5284 is low profile)
- 5286/5288 PCIE2 – 2 port 10GbE SFP+ Copper (5286 is low profile)
- 5769 PCIE1.1 – 1 port 10GbE SR
- 5772 PCIE1.1 – 1 port 10GbE LR
- EC27/EC28 PCIE2 – 2 port 10GbE RoCE SFP+ (EC27 is low profile)
- EC29/EC30 PCIE2 – 2 port 10Gbe RoCE SR (EC29 is low profile)
- 5708 PCIE – 2 port 10Gb FCoE converged network adapter

Basically SR is fibre and SFP+ is copper twinax

If using SFP+ IBM only supports their own cables – they come in 1m, 3m and 5m and are 10GbE SFP+ active twinax cables

Use the PCIE2 cards wherever possible

RoCE – Supports the InfiniBand trade association (IBTA) standard for remote direct memory access (RDMA) over converged Ethernet (RoCE)

More information on adapters at:

http://pic.dhe.ibm.com/infocenter/powersys/v3r1m5/topic/p7hcd/pcibyfeature_77x_78x.htm

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POWER8 - S814 & S824 LAN ADAPTERS

eConfig: Adapters => LAN

(5287)-PCIe2 2-port 10GbE SR Adapter	
(5772)-10 Gigabit Ethernet-LR PCI Express Adapter	
(5899)-PCIe2 4-port 1GbE Adapter	
(EC30)-PCIe2 2-Port 10GbE RoCE SR Adapter	NIM not supported
(EC3B)-PCIe3 2-Port 40GbE NIC RoCE QSFP+ Adapter	
(EN0S)-PCIe2 4-Port (10Gb+1GbE) SR+RJ45 Adapter	NIM not supported
(EN0U)-PCIe2 4-port (10Gb+1GbE) Copper SFP+RJ45 Adapter	NIM not supported
(EN0W)-PCIe2 2-port 10/1GbE BaseT RJ45 Adapter	NIM not supported

eConfig: Adapters => HiPerf/RIO

(EN0H)-PCIe2 4-port (10Gb FCoE & 1GbE) SR&RJ45

You can ignore the FCoE support on this adapter a simply use the 10Gb ports for Ethernet. This adapter supports NIM.
2 ports of 10GbE + (2) ports 1GbE

NIM = Network Install Manager. Used for installing AIX or VIOS over the network instead of DVD drive.

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NETWORK PERFORMANCE AND THROUGHPUT

Depends on:

- Available CPU power
- MTU size
- Distance between receiver and sender
- Offloading features
- Coalescing and aggregation features
- TCP configuration
- Firmware on adapters and server
- Ensuring all known efixes are on for 10GbE issues

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NOTES ON 10GBE

Using jumbo frames better allows you to use the full bandwidth – coordinate with network team first

- Jumbo frames means an MTU size of 9000
- Reduces CPU time needed to forward packets larger than 1500 bytes
- Has no impact on packets smaller than 1500 bytes
- Must be implemented end to end including virtual Ethernet, SEAs, etherchannels, physical adapters, switches, core switches and routers and even firewalls or you will find they fragment your packets
- Throughput can improve by as much as 3X on a virtual ethernet

Manage expectations

- Going from 1GbE to 10GbE does not mean 10x performance
- You will need new cables
- You will use more CPU and memory
  - Network traffic gets buffered
  - This applies to the SEA in the VIOS

Check that the switch can handle all the ports running at 10Gb

Make sure the server actually has enough gas to deliver the data to the network at 10Gb

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10GBE TIPS

Use flow control everywhere – this stops the need for retransmissions

- Need to turn it on at the network switch,
- Turn it on for the adapter in the server
  - chdev –l ent? –a flow_cntrl=yes

If you need significant bandwidth then dedicate the adapter to the LPAR

- There are ways to still make LPM work using scripts to temporarily remove the adapter

TCP Offload settings – largesend and large_receive

- These improve throughput through the TCP stack

Set largesend on (TCP segmentation offload) – should be enabled by default on a 10GbE SR adapter

- AIX - chdev –l en? –a largesend=on
- On vio – chdev –dev ent? –attr largesend=1
- With AIX v7 tl1 or v6 tl7 – chdev –l en? –l mtu_bypass=on

Try setting large_receive on as well (TCP segment aggregation)

- AIX - chdev –l en? –a large_receive=on
- VIO – chdev –dev ent? –attr large_receive=1

If you set large_receive on the SEA the AIX LPARs will inherit the setting

Consider increasing the MTU size (talk to the network team first) – this increases the size of the actual packets

- chdev –l en? mtu=65535 (9000 is what we refer to as jumbo frames)
- This reduces traffic and CPU overhead

If you use ifconfig to make the changes it does not update ODM so the change does not survive a reboot

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10GbE Tips

Low CPU entitlement or too few VPs will impact network performance

- It takes CPU to build those packets

Consider using netperf to test

Network speed between two LPARs on the same box is limited to the virtual Ethernet Speed which is about 0.5 to 1.5 Gb/s

The speed between two LPARs where on is on the SEA and the other is external is the lower of the virtual Ethernet speed above or the speed of the physical network

But all VMs on a server can be sending and receiving at the virtual ethernet speed concurrently

If 10Gb network check out Gareth's Webinar

- https://www.ibm.com/developerworks/wikis/download/attachments/153124943/7_PowerVM_10Gbit_Ethernet.pdf?version=1

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Other Network

SEA failover performance can be improved by setting:

portfast trunk on the switch ports

And by activating:

dead gateway detection with a ping time of 2 seconds

Also look at:

enabling bridge protocol data unit (BPDU) guard on switch ports to protect against spanning tree loops

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VIO 2.2.3 SEA CHANGES

Traditional SEA setup

Ent4 is the virtual adapter defined at the HMC with external access
(SEA goes here)
VIO1 is priority 1 and VIO2 is priority 2
Ent5 is the virtual adapter on Vlan 1 with no external
(IP will go here)
Ent6 is the control channel on vlan 255

mkvdev –sea ent0 –vadapter ent4 –default ent4 –defaultid 1 –attr ha_mode=auto ctl_chan=ent6
Creates ent7 as the SEA

Do not mess up priorities or ctl_chan or you will cause a spanning tree loop

Update with 2.2.3
See chapter 4 of SG248198- Redbook on 2.2.3 Enhancements

SEA setup has been simplified
Requirement removed for dedicated control channel and VLAN ID for each SEA failover configuration
Multiple SEA pairs can now share VLAN 4095 within the same virtual switch and no ctl_chan is needed
HMC (>= 7.8) reserves 4095 for internal management traffic
Requires VIOS 2.2.3, HMC 7.7.8 and firmware 780 or higher

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INSTALLATION

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VIOS AND NIM

Use of NIM to back up, install, and update the VIOS is supported.

Note: For install, always create the SPOT resource directly from the VIOS **mksysb** image. Do NOT update the SPOT from an LPP_SOURCE.

Use of NIM to update the VIOS is supported as follows:
Ensure that the NIM Master is at the appropriate level to support the VIOS image.
http://www14.software.ibm.com/webapp/set2/sas/f/flrt/viostable.html

On the NIM Master, use the operation **updateios** to update the VIOS Server.
"**nim –o updateios –a lpp_source=lpp_source1 ... ...**"

On the NIM Master, use the operation **alt_disk_install** to update an alternate disk copy of the VIOS Server.
"**nim –o alt_disk_install –a source=rootvg –a disk=target_disk –a fix_bundle=(Value) ... ...**"

If NIM is not used to update the VIOS, only the **updateios** or the **alt_root_vg** command from the padmin shell can be used to update the VIOS.

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VIOS AND NIM

Add VIOS partition as a NIM client

Copy the VIOS mksysb image from the CD to your NIM master
- On VIOS 2.2 media there are 3 images now – the 3rd is on DVD 2
- Copy all 3 images individually to a directory and then use cat to combine them

cat /export/mksysb/vios2.2/mksysb_image /export/mksysb/vios2.2/mksysb_image2 /export/mksysb/vios2.2/mksysb_image3 >/export/mksysb/nim_vios2.2mksysb

Define mksysb resource to NIM master

Define spot on NIM master
- The source for the SPOT will be the combined mksysb
- The SPOT CANNOT be created from an LPP_Source

Copy the bosinst.data from the DVD and create a viosbosinst resource

You can now use bos_inst to do a mksysb install once the partition profile is defined

http://www-01.ibm.com/support/docview.wss?uid=isg3T1011386

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MAINTENANCE AND UPGRADES

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UPDATING VIOS

1. Normally upgrade HMC first then firmware then VIOS and then AIX
2. BUT – check the readme for all of the above first to make sure there is not a different required order
3. Download the updates and cross-check compatibility using FLRT
4. Read the readme again
5. Run errpt to check for problems,check there are no stale partitions, missing disks or paths, etc
   - lsvg rootvg checks for stale PPs and physical volumes.
   - lsvg -pv rootvg looks for missing disks.
   - lspath - checks for missing paths.
   - errpt checks for errors.
6. Ensure all paths on clients are redundant so LPARs will stay up when this VIOS is rebooted
7. Run HMC Scanner or sysplan to document prior to changes
8. Backup the VIOS
9. Mount the NFS filesystem or DVD or FBO image to be used for update

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MIGRATION

Back the VIO up before doing anything and again when done!

1. In order to migrate to v2.* your HMC must be at v7 or later at least 7.7.4
If VIOS is lower than v2.1 then you must migrate to 2.0.0 using the migration DVD

2. Migrating from prior to v1.3
   Basically this is a reinstall

3. Migrating from v1.3 or v1.4
   Need the migration DVD for VIOS 1.5 or the updates
   Need to update to VIOS 1.5.2.6-FP-11.1 SP-02 prior to upgrade to v2

4. Migrating from v1.5.2.6-FP-11.1 SP-02 or higher
   Need the migration DVD for VIOS v2
   Boot from the DVD in SMS mode and tell it to do a migration upgrade

Note – once at v2.1 you need to update to 2.2.3.1 prior to applying 2.2.3.3
2.2.3.3 requires a minimum release of 2.2.3.0 in order to be applied
Single step update requires VIO between 2.2.1.1 and 2.2.2.x
NIM allows you to create a single merged lpp_source to get around this but cannot be used with SDDPCM

5. See Power VM Managing and Monitoring Redbook – Chapter 11
   http://www.redbooks.ibm.com/redbooks/pdfs/sg247590.pdf

Once you are on v2.1 then upgrades are all done using updateios
There are specific concerns around updates if you are running SSPs (Shared storage pools)

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UPDATING VIOS WITH FIXPACKS OR SPS

From 2.2.3.2 to 2.2.3.3
As padmin run “updateios –commit” to ensure any uncommitted updates are committed
Check to ensure there are no missing filesets prior to updates

$ ioslevel
2.2.3.2
$ updateios -commit
All updates have been committed.

$ oem_setup_env
# /usr/sbin/emgr –P
There is no efix data on this system.

Now run checks

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PRE INSTALL CHECKS FOR VIOS 2.2.3.2 TO 2.2.3.3 UPDATE

Did VIO2 (secondary VIO first):
$ ioslevel
2.2.3.2
$ oem_setup_env
#df –g - make sure no filesystems are full
#oslevel -s
6100-09-02-1412
instfix -i | grep ML
  All filesets for 6.1.0.0_AIX_ML were found.
  All filesets for 6100-00_AIX_ML were found.
  All filesets for 6100-01_AIX_ML were found.
  All filesets for 6100-02_AIX_ML were found.
  All filesets for 6100-03_AIX_ML were found.
  All filesets for 6100-04_AIX_ML were found.
  All filesets for 6100-05_AIX_ML were found.
  All filesets for 6100-06_AIX_ML were found.
  All filesets for 6100-07_AIX_ML were found.
  All filesets for 6100-08_AIX_ML were found.
  All filesets for 6100-09_AIX_ML were found.
lppchk -v
lppchk -vm3
oslevel -s -l 6100-09-02-1412
#errpt | more – check there are no errors

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CONTINUE 2.2.3.3 UPDATE BACKUP 1/2

Back it up:
./save-viostuff.sh
mkdir: 0653-358 Cannot create /home/padmin/saveit.
/home/padmin/saveit: Do not specify an existing file.

ls -l /home/padmin/saveit
total 824
-rw-r--r-- 1 root staff 118 Jul 22 12:33 b740vio2.disktmp.txt
-rw-r--r-- 1 root staff 24 Jul 22 12:33 b740vio2.ioslevel.txt
-rw-r--r-- 1 root staff 16 Jul 22 12:33 b740vio2.oslevel.txt
-rw-r--r-- 1 root staff 8038 Jul 22 12:33 b740vio2.vioadapter.txt
-rw-r--r-- 1 root staff 4528 Jul 22 12:33 b740vio2.viodisk.txt
-rw-r--r-- 1 root staff 59593 Jul 22 12:33 b740vio2.viodisks.txt
-rw-r--r-- 1 root staff 8800 Jul 22 12:33 b740vio2.violsdevv.txt
-rw-r--r-- 1 root staff 11967 Jul 22 12:33 b740vio2.violsmapall.npiv.txt
-rw-r--r-- 1 root staff 19363 Jul 22 12:33 b740vio2.violsmapall.txt
-rw-r--r-- 1 root staff 4595 Jul 22 12:33 b740vio2.vioslots.txt
-rw-r--r-- 1 root staff 227944 Jul 22 12:33 b740vio2.viovpd.txt
-rw-r--r-- 1 root staff 37 Jul 22 12:33 cfgname.txt
-rw-r--r-- 1 root staff 0 Jul 22 12:33 entstat.txt
-rw-r--r-- 1 root staff 240 Jul 22 12:33 firewall.txt
-rw-r--r-- 1 root staff 652 Jul 22 12:33 hostmap.txt
-rw-r--r-- 1 root staff 5970 Jul 22 12:33 optimize.txt
-rw-r--r-- 1 root staff 713 Jul 22 12:33 routinfo.txt
-rw-r--r-- 1 root staff 240 Jul 22 12:33 user.txt
-rw-r--r-- 1 root staff 15071 Jul 22 12:33 view.txt

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CONTINUE 2.2.3.3 UPDATE BACKUP 2/2

```
$ viosbr -backup -file /home/padmin/saveit/b740vio2-backup
Backup of this node (b740vio2) successful

$ savevgstruct rootclients_vg
Creating information file for volume group rootclients_vg.
Creating list of files to back up.
Backing up 6 files
6 of 6 files (100%)
0512-038 savevg: Backup Completed Successfully.

oem_setup_env
# mount /usr/local/backups
# su - padmin -c "ioscli backupios -file /usr/local/backups/b740vio2-jul2214.mksysb  -mksysb"
/usr/local/backups/b740vio2-jul2214.mksysb  doesn't exist.
Creating /usr/local/backups/b740vio2-jul2214.mksysb
Creating information file for volume group rootclients_vg.
Creating list of files to back up.
Backing up 6 files
6 of 6 files (100%)
0512-038 savevg: Backup Completed Successfully.
Backup in progress.  This command can take a considerable amount of time
to complete, please be patient...

Creating information file (/image.data) for rootvg.
Creating list of files to back up.
Backing up 160374 files.....................
39229 of 160374 files (24%).....................
160374 of 160374 files (100%)
0512-038 savevg: Backup Completed Successfully.
```

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CONTINUE 2.2.3.3 UPDATE INSTALL

Download from Fix Central the iso image for 2.2.3.3 – I do this to my NIM server
It came down as H52175995.iso
mkdir /cdrom
loopmount -i H52175995.iso -o "-V cdrfs -o ro" -m /cdrom
smitty bffcreate – I do this on my NIM server and create a directory to put the files in that the VIO has access to
In this case /usr/local/soft/vios2233

Now on the VIO:
$ updateios -accept -install -dev /usr/local/soft/vios2233

```
********************************************************************************
installp PREVIEW:  installation will not actually occur.
********************************************************************************
+-----------------------------------------------------------------------------+
                    Pre-installation Verification...
+-----------------------------------------------------------------------------+
Verifying selections...done
Verifying requisites...done
Results...
SUCCESSES
---------
  Filesets listed in this section passed pre-installation verification
  and will be installed.
  Mandatory Fileset Updates
  ------------------------
  (being installed automatically due to their importance)
  bos.rte.install 6.1.9.16                 # LPP Install Commands
  << End of Success Section >>
```

Prompts you to reply Y which you do and it installs them

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CONTINUE 2.2.3.3 UPDATE INSTALL

After bos.rte.install is installed it then prompts you re installing the other 272 fixes
Check estimated space needed and free space and if all is good then:
Reply Y and they begin installing – takes about 2 hours depending

$ioslevel
Shows as 2.2.3.3

$oem_setup_env
oslevel -s
6100-09-03-1415

lspv | grep rootvg
hdisk0 00f6934cc34a30f3 rootvg active
hdisk1 00f6934c30e34699 rootvg active

bosboot –a –d hdisk0
bosboot –a –d hdisk1
bootlist –m normal hdisk0 hdisk1

Now reboot and then run post install tests

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POST INSTALL CHECKS

$ ioslevel
2.2.3.3

$ oem_setup_env
# oslevel -s
Should show: 6100-09-03-1415
6100-09-03-1415

instfix -i | grep ML
All filesets for 6100-00_AIX_ML were found.
All filesets for 6100-01_AIX_ML were found.
All filesets for 6100-02_AIX_ML were found.
All filesets for 6100-03_AIX_ML were found.
All filesets for 6100-04_AIX_ML were found.
All filesets for 6100-05_AIX_ML were found.
All filesets for 6100-06_AIX_ML were found.
All filesets for 6100-07_AIX_ML were found.
All filesets for 6.1.0.0_AIX_ML were found.
All filesets for 6100-08_AIX_ML were found.
All filesets for 6100-09_AIX_ML were found.
lppchk -v
lppchk -vm3
oslevel -s -l 6100-09-03-1415
#errpt | more – check there are no errors

Once all checks are passed and VIO2 is back up then go do the same upgrade to VIO1

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UPDATING VIOS PROBLEMS

```
oem_setup_env
oslevel –s
6100-00-00-0000
instfix -i | grep ML
   All filesets for 6100-07_AIX_ML were found.
   All filesets for 6.1.0.0_AIX_ML were found.
   Not all filesets for 6100-08_AIX_ML were found.
This means there are missing filesets
# oslevel -sq
Known Service Packs
------------------
6100-08-02-1316
6100-08-01-1245

# oslevel -s -l 6100-08-02-1316
Fileset                          Actual Level      Service Pack Level
-------------------------------------------------------------------------------
bos.alt_disk_install.boot_images      6.1.8.0          6.1.8.15
bos.loc.utf.ES_ES                     6.1.7.15         6.1.8.15

These filesets should be corrected prior to updating
Either use updateios to update them or to remove them
```

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REMOVE OR UPDATE PROBLEM FILESETS

```
DO NOT USE SMITTY – use updateios

Issues with bos.suma
updateios –remove bos.suma

# oslevel -s -l 6100-08-02-1316
Fileset                          Actual Level      Service Pack Level
-------------------------------------------------------------------------------
bos.alt_disk_install.boot_images      6.1.8.0          6.1.8.15
bos.loc.utf.ES_ES                     6.1.7.15         6.1.8.15

updateios –remove bos.loc.utf.ES_ES

Upgrade alt disk
Copy images to be updated into a directory (/usr/local/soft/missing)
Run inutoc .

updateios –commit
Updateios -accept -install -dev /usr/local/soft/missing

Also remove efixes prior to updates:
/usr/sbin/emgr –P   lists them

To remove:
# /usr/sbin/emgr -r -L <EFIX label>
emgr -r -L IV46869m3a
```

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BACKUP AND RECOVERY

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BACKING UP VIOS

Use viosbr to backup user defined virtual resources on the VIO
Make sure to save that backup in rootvg

- viosbr –backup –file /tmp/viosabkupbr
- You can also use viosbr to view or restore
- http://publib.boulder.ibm.com/infocenter/systems/scope/hw/topic/p7hcg/viosbr.htm

Mount NFS filesystem to backup to (in my case /backups)

mkdir /backups/viosa

Then as padmin:
backupios –file /backups/viosa
The above creates a nim_resources.tar package in that directory and it can be used to clone VIO servers

You can also back it up as a mksysb file that is easy to restore from the NIM server
backupios -file /backups/viosa.mksysb -mksysb

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BACKING UP VIOS FROM ROOT

As root run viosave.sh (see next slide)

lsvg – if you have other VGs i.e. datavg then for each …..
su - padmin -c "ioscli savevgstruct datavg"
su - padmin -c "ioscli viosbr –backup –file /tmp/viosabr.backup”

Mount the NFS repository for the backups (/nfsmnt)
su – padmin –c “ioscli backupios –file /nfsmnt/vio2-jul2114.mksysb -mksysb”

This backs it up to a bootable mksysb file

To use the mksysb with NIM replace the backupios command above with:
backupios -file /nfsmnt/nimbkups

This creates a nim_resources.tar file that can be used for restores described at:
http://public.dhe.ibm.com/software/server/vios/docs/backupios_mod.pdf

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DOCUMENT VIO INFORMATION – VIOSAVE.SH

```
#! /bin/sh
#
day="`/bin/date +'%d'`"
month="`/bin/date +'%m'`"
year="`/bin/date +'%y'`"
set -- Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
shift $month
lmonth="$1"
machine=`uname -n`
directory="`/bin/date +'%m%d%Y_%H%M'`"
machine_directory=`printf "%s_%s" $machine $directory`
mkdir /home/padmin/saveit
cd /home/padmin/saveit
logit="/home/padmin/saveit/$machine"
logit1="/home/padmin/saveit/$machine"
su - padmin -c "ioscli ioslevel" >>$logit1.ioslevel.txt
su - padmin -c "ioscli lsdev -type disk" >>$logit1.viodisk.txt
su - padmin -c "ioscli lsdev -type adapter" >>$logit1.vioadapter.txt
su - padmin -c "ioscli lsdev -vpd" >>$logit1.viovpd.txt
su - padmin -c "ioscli lsdev -slots" >>$logit1.vioslots.txt
su - padmin -c "ioscli lsmap -all" >>$logit1.violsmapall.txt
su - padmin -c "ioscli lsmap -all -npiv" >>$logit1.violsmapall.npiv.txt
su - padmin -c "ioscli lsdev -virtual" >>$logit1.violsdevv.txt
su - padmin -c "ioscli cfgnamesrv -ls " >cfgname.txt
su - padmin -c "ioscli entstat -all ent9 "  >entstat.txt
su - padmin -c "ioscli hostmap -ls" >hostmap.txt
su - padmin -c "ioscli lsuser" >user.txt
su - padmin -c "ioscli netstat -routinfo" >routinfo.txt
su - padmin -c "ioscli optimizenet -list" >optimize.txt
su - padmin -c "ioscli viosecure -firewall view" >firewall.txt
su - padmin -c "ioscli viosecure -view -nonint" >view.txt
oslevel -s >$logit1.oslevel.txt
getlvodm -C > $logit1.disktmp.txt
while read label line
do
  echo "\n" >>$logit1.viodisks.txt
  echo "Hdisk is $label" >>$logit1.viodisks.txt
  echo " " >>$logit1.viodisks.txt
  su - padmin -c "ioscli lsdev -dev $label -attr" >>$logit1.viodisks.txt
done <"$logit1.disktmp.txt"
#
exit 0
```


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MONITORING

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NETSTAT -V

ETHERNET STATISTICS (ent18) :
Device Type: Shared Ethernet Adapter
Elapsed Time: 44 days 4 hours 21 minutes 3 seconds

Transmit Statistics:	Receive Statistics:
Packets: 94747296468	Packets: 94747124969
Bytes: 99551035538979	Bytes: 99550991883196
Interrupts: 0	Interrupts: 22738616174
Transmit Errors: 0	Receive Errors: 0
Packets Dropped: 0	Packets Dropped: 286155
	Bad Packets: 0

Max Packets on S/W Transmit Queue: 712
S/W Transmit Queue Overflow: 0
Current S/W+H/W Transmit Queue Length: 50

Elapsed Time: 0 days 0 hours 0 minutes 0 seconds

Broadcast Packets: 3227715	Broadcast Packets: 3221586
Multicast Packets: 3394222	Multicast Packets: 3903090
No Carrier Sense: 0	CRC Errors: 0
DMA Underrun: 0	DMA Overrun: 0
Lost CTS Errors: 0	Alignment Errors: 0
Max Collision Errors: 0	**No Resource Errors: 286155 check those tiny, etc Buffers**
Late Collision Errors: 0	Receive Collision Errors: 0
Deferred: 0	Packet Too Short Errors: 0
SQE Test: 0	Packet Too Long Errors: 0
Timeout Errors: 0	Packets Discarded by Adapter: 0
Single Collision Count: 0	Receiver Start Count: 0

Multiple Collision Count: 0
Current HW Transmit Queue Length: 50

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NETSTAT –V VIO

SEA

Transmit Statistics:	Receive Statistics:
Packets: 83329901816	Packets: 83491933633
Bytes: 87482716994025	Bytes: 87620268594031
Interrupts: 0	Interrupts: 18848013287
Transmit Errors: 0	Receive Errors: 0
Packets Dropped: 0	**Packets Dropped: 67836309**
	Bad Packets: 0

Max Packets on S/W Transmit Queue: 374
S/W Transmit Queue Overflow: 0
Current S/W+H/W Transmit Queue Length: 0

Elapsed Time: 0 days 0 hours 0 minutes 0 seconds

Broadcast Packets: 1077222	Broadcast Packets: 1075746
Multicast Packets: 3194318	Multicast Packets: 3194313
No Carrier Sense: 0	CRC Errors: 0
DMA Underrun: 0	DMA Overrun: 0
Lost CTS Errors: 0	Alignment Errors: 0
Max Collision Errors: 0	**No Resource Errors: 67836309**

Virtual I/O Ethernet Adapter (l-lan) Specific Statistics:

Hypervisor Send Failures: 4043136
Receiver Failures: 4043136
Send Errors: 0
Hypervisor Receive Failures: 67836309

"No Resource Errors" can occur when the appropriate amount of memory can not be added quickly to vent buffer space for a workload situation.

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BUFFERS

Virtual Trunk Statistics
Receive Information
Receive Buffers

Buffer Type		Tiny	Small	Medium	Large	Huge
Min Buffers		512	512	128	24	24
Max Buffers		2048	**2048**	256	64	64
Allocated		513	2042	128	24	24
Registered		511	506	128	24	24
History						
Max Allocated	532	**2048**	128	24	24	
Lowest Registered	502	354	128	24	24	

"Max Allocated" represents the maximum number of buffers ever allocated
"Min Buffers" is number of pre-allocated buffers
"Max Buffers" is an absolute threshhold for how many buffers can be allocated

chdev –l <veth> -a max_buf_small=4096 –P
chdev –l <veth> -a min_buf_small=2048 –P
Above increases min and max small buffers for the virtual ethernet adapter configured for the SEA above
Needs a reboot

Max buffers is an absolute threshold for how many buffers can be allocated
Use entstat –d (-all on vio) or netstat –v to get this information

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NMON MONITORING

nmon -ft –AOPV^dMLW -s 15 -c 120

- Grabs a 30 minute nmon snapshot
- A is async IO
- M is mempages
- t is top processes
- L is large pages
- **O is SEA on the VIO**
- P is paging space
- V is disk volume group
- d is disk service times
- ^ is fibre adapter stats
- W is workload manager statistics if you have WLM enabled

If you want a 24 hour nmon use:

nmon -ft –AOPV^dMLW -s 150 -c 576

May need to enable accounting on the SEA first – this is done on the VIO
chdev –dev ent* -attr accounting=enabled

Can use entstat/seastat or topas/nmon to monitor – this is done on the vios
topas –E
nmon -O

VIOS performance advisor also reports on the SEAs

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DPO (DYNAMIC PLATFORM OPTIMIZER)

PowerVM feature requiring firmware 760 and HMC 7.6.0 or greater

DPO aware O/S

- AIX v6.1 TL08, VIOS 2.2.2.0, AIX v7.1 TL02, IBM I 7.1 PTF MF56058, RHEL 7, SLES 12
- Earlier systems will work but will need a reboot after running DPO

No value on single-socket servers

Used to improve system wide partition memory and processor placement (affinity)

Tries to assign local memory to CPUs, reducing memory access time

Launched via HMC using the optmem command

lsoptmem command shows current and predicted memory affinity

See chapter 15 of the PowerVM Managing and Monitoring Redbook SG24-7590

- http://www.redbooks.ibm.com/redbooks/pdfs/sg247590.pdf

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DSO (Dynamic System Optimizer)

PowerVM and AIX feature

- P7 or P7+
- AIX v6.1 TL08 SP1 or AIX v7.1 TL02 SP1
- Cannot be using AMS (Active memory sharing)
- Chargeable feature via an enablement fileset

Dynamically tunes the allocation of system resources within an LPAR

- Identifies and optimizes workloads
- Tries to optimize cache affinity, memory affinity, use of large pages, hardware pre-fetch

See chapter 16 of the PowerVM Managing and Monitoring Redbook SG24-7590

- http://www.redbooks.ibm.com/redbooks/pdfs/sg247590.pdf

Whitepaper at:

- http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?infotype=SA&subtype=WH&htmlfid=POW03093USEN

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Shared Processor Pool Monitoring

Turn on “Allow performance information collection” on the LPAR properties
This is a dynamic change

topas –C
Most important value is app – available pool processors
This represents the current number of free physical cores in the pool

nmon option p for pool monitoring
To the right of PoolCPUs there is an unused column which is the number of free pool cores

nmon analyser LPAR Tab

lparstat
Shows the app column and poolsize

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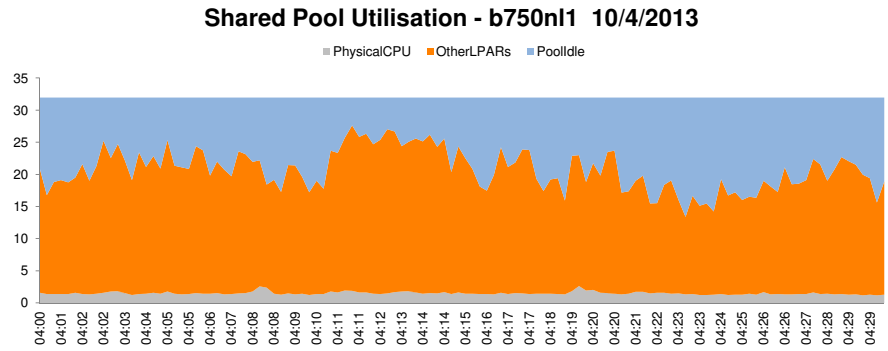
NMON ANALYSER LPAR TAB



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FBO – FILE BACKED OPTICAL

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FBO

Provides ISO image access to LPARs connected to the VIO
Uses vSCSI
Add third disk to one of the VIO servers and put in its own VG
Use that VG as the repository
Rip DVDs to ISO images (or download the ISOs)
Can also put mksysb images in the repository

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USING FBO

So using hdisk2 as my third disk I create a VG:

```
mkvg –y datavg hdisk2
mkrep –sp datavg –size 10G
```

This can be increased later and creates:

```
/dev/VMLibrary     10.00      5.85   42%       7     1% /var/vio/VMLibrary
```

We can now load images into the repository from an ISO we have on NFS:

```
mkvopt -name rhelboot64  -file /usr/local/nfsmnt/rhel-64bit-basedvd.iso
```

This takes the ISO and copies it as follows:

```
$ ls -l /var/vio/VMLibrary
-rw-------    1 root     staff     237981696 Jul 25 13:14 rhelboot64
```

To list the repository:

```
$ lsrep
Size(mb) Free(mb) Parent Pool       Parent Size      Parent Free
   10199     5989      datavg             279552           157696
Name                                File Size Optical       Access
rhelboot64                               227 None          rw
```

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USING FBO

In order to use the repository, the virtual host has to be assigned a virtual SCSI FBO adapter; do so with:
mkvdev -fbo -vadapter vhost0
vtopt0 available

Multiple vtopt devices for a client can be created, if desired.
Now make the image available to vtopt0:
loadopt -vtd vtopt0 -disk rhelboot64
loadopt -disk p8aix71base1 -vtd vtopt0

This example would mount rhelboot64 or p8aix71base1 as if it were a local CD. To unmount it, use:
unloadopt -vtd vtopt0

Also, **rmvopt** removes an image; **rmrep** removes a repository; and **lsvopt** lists the state of the vtopts:

```
$ lsvopt
VTD          Media                             Size(mb)
vtopt0       No Media                             n/a
```

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MY POWER8 VIO FBO

```
$ lsrep
Size(mb) Free(mb) Parent Pool       Parent Size      Parent Free
  511414   490594 fbovg                1089024           577024

Name                                  File Size Optical      Access
p8aix61base1                                4423 None         rw
p8aix61base2                                2265 None         rw
p8aix71base1                                4089 None         rw
p8aix71base2                                3035 None         rw
p8rhel7                                     1334 None         rw
p8ubuntu                                     655 None         rw
p8viosbase1                                 3913 None         rw
p8viosbase2                                 1106 None         rw

$ lssp
Pool          Size(mb)   Free(mb)  Alloc Size(mb)    BDs Type
rootvg          540672     407552            512     2 LVPOOL
fbovg          1089024     577024            512     1 LVPOOL

$ lsvopt
VTD          Media                             Size(mb)
vtopt0       No Media                             n/a
vtopt1       No Media                             n/a
vtopt2       No Media                             n/a
vtopt3       No Media                             n/a
```

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OTHER FBO COMMANDS

padmin

- chrep
- chvopt
- loadopt
- lsrep
- lsvopt
- mkrep
- mkvopt
- rmrep
- rmvopt
- unloadopt
- lssp
- mkvdev

You can then run help <command>

As root
- lsvg
- mkvg

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OTHER

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USEFUL COMMANDS

Command History
$ fc -l
725 lsrep
726 backupios -file /usr/local/backups/b750viobkp
727 exit
728 lsmap -vadapter vhost0
729 fc –l

Global command log
$ lsgcl | grep "Aug 9 2013"
Aug 9 2013, 08:25:35 root ioslevel
Aug 9 2013, 08:59:22 padmin license
Aug 9 2013, 09:00:29 padmin lsmap -vadapter vhost0
Aug 9 2013, 09:01:29 padmin lsgcl

Redirecting output when running as padmin
lsmap –all –npiv | tee npivdata.txt

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USEFUL COMMANDS

vSCSI Commands
mkvdev -vdev hdisk2 -vadapter vhost0
mkvdev –fbo –vadapter vhost0

NPIV
Setup NPIV mappings
vfcmap –vadapter vfchost0 –fcp fcs0
lsmap –npiv –all
lsmap –vadapter vfchost0 –npiv
lsdev –virtual
lsnports
lsdev –slots
lscfg –vpl vfchost0

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USEFUL COMMANDS

$ lsdev -virtual

```
name             status      description
ent5             Available   Virtual I/O Ethernet Adapter (l-lan)
ent6             Available   Virtual I/O Ethernet Adapter (l-lan)
ent7             Available   Virtual I/O Ethernet Adapter (l-lan)
vasi0            Available   Virtual Asynchronous Services Interface (VASI)
vbsd0            Available   Virtual Block Storage Device (VBSD)
vfchost0         Available   Virtual FC Server Adapter
vfchost1         Available   Virtual FC Server Adapter
vfchost2         Available   Virtual FC Server Adapter
vfchost3         Available   Virtual FC Server Adapter
vhost0           Available   Virtual SCSI Server Adapter
vhost1           Available   Virtual SCSI Server Adapter
vhost2           Available   Virtual SCSI Server Adapter
vhost3           Available   Virtual SCSI Server Adapter
vsa0             Available   LPAR Virtual Serial Adapter
b740ios1_rv1     Available   Virtual Target Device - Logical Volume
b740l1_rv1       Available   Virtual Target Device - Logical Volume
vtopt0           Available   Virtual Target Device - File-backed Optical
vtopt1           Available   Virtual Target Device - File-backed Optical
vtopt2           Available   Virtual Target Device - File-backed Optical
vtopt3           Available   Virtual Target Device - File-backed Optical
vtscsi0          Available   Virtual Target Device - Disk
vtscsi1          Available   Virtual Target Device - Disk
vtscsi2          Available   Virtual Target Device - Disk
vtscsi3          Available   Virtual Target Device - Disk
ent8             Available   Shared Ethernet Adapter
```

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USEFUL COMMANDS

$ lsmap -vadapter vhost0

```
SVSA            Physloc                                     Client Partition ID
--------------- ------------------------------------------- ------------------
vhost0          U8205.E6B.10934CP-V1-C21                    0x00000003

VTD                   b740l1_rv1
Status                Available
LUN                   0x8300000000000000
Backing device        lv_b740l1
Physloc
Mirrored              N/A

VTD                   vtopt0
Status                Available
LUN                   0x8200000000000000
Backing device
Physloc
Mirrored              N/A

VTD                   vtopt1
Status                Available
LUN                   0x8100000000000000
Backing device
Physloc
Mirrored              N/A
```

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USEFUL COMMANDS

$ lsmap -vadapter vfchost0 -npiv

```
Name          Physloc                          ClntID ClntName       ClntOS
------------- ---------------------------------- ------ -------------- -------
vfchost0      U8205.E6B.10934CP-V1-C31              3

Status:NOT_LOGGED_IN
FC name:fcs0                  FC loc code:U78AA.001.WZSG8PD-P1-C5-T1
Ports logged in:0
Flags:4<NOT_LOGGED>
VFC client name:              VFC client DRC:
```

$ lsmap -vadapter vfchost4 -npiv

```
Name          Physloc                          ClntID ClntName       ClntOS
------------- ---------------------------------- ------ -------------- -------
vfchost4      U8205.E6B.10934CP-V1-C36              8 b740nl1        AIX

Status:LOGGED_IN
FC name:fcs0                  FC loc code:U78AA.001.WZSG8PD-P1-C5-T1
Ports logged in:3
Flags:a<LOGGED_IN,STRIP_MERGE>
VFC client name:fcs0          VFC client DRC:U8205.E6B.10934CP-V8-C36
```

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FORSYTHE

USEFUL COMMANDS

$ lsnports

```
name             physloc                          fabric tports aports swwpns  awwpns
fcs0             U78AA.001.WZSG8PD-P1-C5-T1            1     64     63       2048       2041
```

$ lsdev -slots

```
# Slot                      Description       Device(s)
HEA 1                       Logical I/O Slot  lhea0 ent0
U8205.E6B.10934CP-V1-C0     Virtual I/O Slot  vsa0
U8205.E6B.10934CP-V1-C11    Virtual I/O Slot  ent5
U8205.E6B.10934CP-V1-C12    Virtual I/O Slot  ent6
U8205.E6B.10934CP-V1-C13    Virtual I/O Slot  ent7
U8205.E6B.10934CP-V1-C21    Virtual I/O Slot  vhost0
U8205.E6B.10934CP-V1-C22    Virtual I/O Slot  vhost1
U8205.E6B.10934CP-V1-C23    Virtual I/O Slot  vhost2
U8205.E6B.10934CP-V1-C31    Virtual I/O Slot  vfchost0
U8205.E6B.10934CP-V1-C32    Virtual I/O Slot  vfchost1
U8205.E6B.10934CP-V1-C33    Virtual I/O Slot  vfchost2
U8205.E6B.10934CP-V1-C32769 Virtual I/O Slot  vasi0
U8205.E6B.10934CP-V1-C32773 Virtual I/O Slot  vasi1
U8205.E6B.10934CP-V1-C32774 Virtual I/O Slot  vasi2
U8205.E6B.10934CP-V1-C32775 Virtual I/O Slot  vasi3
U8205.E6B.10934CP-V1-C32776 Virtual I/O Slot  vasi4
```

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USEFUL HMC COMMANDS

ssh to HMC as hscroot or your userid

Useful Commands:

lshmc
vtmenu - way better than ascii console
lshwres

monhmc –r mem –n 0	how much memory do I have?
monhmc –r proc –n 0	CPU usage
monhmc –r swap –n 0	Page space
monhmc –r disk –n 0	What is my disk utilization?
chhmcfs –r disk –n 0	Clear out all temp files
lshmcfs	
hmcshutdown –r –t now	Reboot HMC

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USEFUL HMC COMMANDS – 7042-CR6

hscroot@bpichmc:~>monhmc -r mem -n 0
Mem: 4043216k total, 3885308k used, 157908k free, 484132k buffers (has 4GB)

hscroot@bpichmc:~>monhmc -r proc -n 0
Cpu0 : 0.0%us, 0.7%sy, 0.0%ni, 98.3%id, 1.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu1 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu2 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu3 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st

hscroot@bpichmc:~>monhmc -r swap -n 0
Swap: 2040244k total, 137456k used, 1902788k free, 1036824k cached

hscroot@bpichmc:~>monhmc -r disk -n 0

Filesystem	1K-blocks	Used	Available	Use%	Mounted on
/dev/sda2	16121184	7100064	8202208	47%	/
/dev/sda3	6040320	297672	5435808	6%	/var
/dev/mapper/HMCDataVG-HomeLV	10321208	245052	9551868	3%	/home
/dev/mapper/HMCDataVG-LogLV	8256952	1292372	6545152	17%	/var/hsc/log
/dev/mapper/HMCDataVG-DumpLV	123854820	319672	117243692	1%	/dump
/dev/mapper/HMCDataVG-ExtraLV	20642428	198692	19395160	2%	/extra
/dev/mapper/HMCDataVG-DataLV	227067260	455376	215077548	1%	/data

hscroot@bpichmc:~>lshmcfs
filesystem=/var,filesystem_size=8063,filesystem_avail=6390,temp_files_start_time=07/14/2014 13:11:00,temp_files_size=783
filesystem=/dump,filesystem_size=120951,filesystem_avail=114495,temp_files_start_time=07/14/2014 21:09:00,temp_files_size=0
filesystem=/extra,filesystem_size=20158,filesystem_avail=18940,temp_files_start_time=none,temp_files_size=0
filesystem=/,filesystem_size=15743,filesystem_avail=8009,temp_files_start_time=07/22/2014 23:18:00,temp_files_size=0

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USEFUL HMC COMMANDS – 7042-CR7

hscroot@bpic8hmc:~>monhmc -r mem -n 0
Mem: 41263576k total, 3608896k used, 37654680k free, 551600k buffers
Either it has 41GB memory or there is a bug ☺

hscroot@bpic8hmc:~>monhmc -r proc -n 0
Cpu0 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu1 : 0.0%us, 0.3%sy, 0.0%ni, 99.7%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu2 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu3 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu4 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Cpu5 : 0.0%us, 0.0%sy, 0.0%ni,100.0%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st

hscroot@bpic8hmc:~>monhmc -r swap -n 0
Swap: 2040244k total, 0k used, 2040244k free, 934024k cached

hscroot@bpic8hmc:~>monhmc -r disk -n 0

Filesystem	1K-blocks	Used	Available	Use%	Mounted on
/dev/sda2	16121184	6715032	8587240	44%	/
/dev/sda3	6040320	270112	5463368	5%	/var
/dev/mapper/HMCDataVG-HomeLV	10321208	244856	9552064	3%	/home
/dev/mapper/HMCDataVG-LogLV	8256952	479796	7357728	7%	/var/hsc/log
/dev/mapper/HMCDataVG-DumpLV	61927420	187024	58594668	1%	/dump
/dev/mapper/HMCDataVG-ExtraLV	20642428	198692	19395160	2%	/extra
/dev/mapper/HMCDataVG-DataLV	144497320	195428	136961860	1%	/data

hscroot@bpic8hmc:~>lshmcfs
filesystem=/var,filesystem_size=8063,filesystem_avail=7185,temp_files_start_time=07/14/2014 16:33:00,temp_files_size=318
filesystem=/dump,filesystem_size=60475,filesystem_avail=57221,temp_files_start_time=07/14/2014 20:15:00,temp_files_size=0
filesystem=/extra,filesystem_size=20158,filesystem_avail=18940,temp_files_start_time=none,temp_files_size=0
filesystem=/,filesystem_size=15743,filesystem_avail=8385,temp_files_start_time=07/22/2014 22:43:00,temp_files_size=0

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USEFUL HMC COMMANDS

lshmc
-V - Displays HMC version information.
-v - Displays HMC VPD information.
-r - Displays HMC remote access settings.
-n - Displays HMC network settings.
-b - Displays the BIOS level of the HMC.
-l - Displays the current locale for the HMC.
-L - Displays all supported locales for the HMC.
-h - Displays HMC hardware information.
-i - Displays HMC Integrated Management Module (IMM) settings.
-e - Displays HMC settings for Events Manager for Call Home.
-F [<attribute names>] - delimiter-separated list of the names of the attributes to be listed for the specified HMC setting. If no attribute names are specified, then all attributes will be listed.
--header - prints a header of attribute names when -F is also specified
--help - prints this help

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USEFUL HMC COMMANDS

ssh to HMC as hscroot or your userid

hscroot@bpichmc:~>lshmc -V
"version= Version: 8
 Release: 8.1.0
 Service Pack: 0
HMC Build level 20140602.3
MH01421: Required fix for HMC V8R8.1.0 (06-03-2014)
MH01436: Fix for OpenSSL,GnuTLS (06-11-2014)
MH01441: Fix for HMC V8R8.1.0 (06-23-2014)
","base_version=V8R8.1.0
"

hscroot@bpichmc:~>lshmc -v
"vpd=*FC ????????
*VC 20.0
*N2 Wed Jul 23 04:45:57 UTC 2014
*FC ????????
*DS Hardware Management Console
*TM 7042-CR6
*SE 102EEEC
*MN IBM
*PN 0B20PT
*SZ 4140253184
*OS Embedded Operating Systems
*NA 10.250.134.20
*FC ????????
*DS Platform Firmware
*RM V8R8.1.0.0
"

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USEFUL HMC COMMANDS

hscroot@bpichmc:~>lshmc -b
"bios=D6E149AUS-1.09
"

hscroot@bpichmc:~>lshmc -r
ssh=enable,sshprotocol=,remotewebui=enable,xntp=disable,xntpserver=127.127.1.0,syslogserver=,syslog
tcpserver=,syslogtlsserver=,altdiskboot=disable,ldap=disable,kerberos=disable,kerberos_default_realm=,k
erberos_realm_kdc=,kerberos_clockskew=,kerberos_ticket_lifetime=,kpasswd_admin=,trace=,kerberos_k
eyfile_present=,kerberos_allow_weak_crypto=,legacyhmccomm=disable,security=legacy,sol=disabled

hscroot@bpichmc:~>lshmc -e
emch=disabled,callhome=enabled,registered_hmcs=

On HMC check LMB sizes
hscroot@bpichmc:~>lshwres -r mem -m p740-Server-8205-E6B-SN10934CP --level sys -F
mem_region_size
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USEFUL HMC COMMANDS – HMC UPDATES

ssh to HMC as hscroot or your userid

Use with great care

saveupgdata –r disk

getupgfiles -h public.dhe.ibm.com -u anonymous --passwd anonymous -d /software/server/hmc/network/v8810

ls –la /hmcdump

chhmc –c altdiskboot –s enable –mode upgrade

tail -f /tmp/HmcInstall.log during upgrade

Directories on FTP Server (ftp.software.ibm.com)
Upgrades: /software/server/hmc/network/v8810
Fixes: /software/server/hmc/fixes
Service Packs: /software/server/hmc/updates

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HMC SCANNER

Latest HMC Scanner is available at http://tinyurl.com/HMCscanner

Java program that uses SSH to connect to HMC, FSM or IVM to gather information about the system configuration

I run it on one of the AIX Systems as follows:

- ./hmcScanner.ksh servername hscroot -p password -stats –sanitize
- Sanitize causes it to produce two spreadsheets – one that has been cleansed of identifying data

Information is organized in tabs in an excel spreadsheet:

- System summary: name, serial number, cores, memory, service processor IP for each server
- LPAR Summary: list of all LPAR by serve with status, environment, version, processor mode
- LPAR CPU: processor configuration of each LPAR
- LPAR MEM: memory configuration of each LPAR
- Physical Slots: list of all slots of each system with LPAR assignment, description, physical location and drc_index
- Virtual Ethernet: network configuration of each virtual switch and each LPAR
- Virtual SCSI: configuration of all virtual SCSI adapters, both client and server
- VSCSI Map: devices mapped by each VIOS to partitions
- Virtual Fibre: virtual fibre channel configuration of client and server with identification of physical adapter assigned
- **SEA**: SEA configuration and statistics for all VIOS
- SW Cores: LPAR and virtual processor pool configuration matrix to compute the number of software licenses. Simulation of alternative scenarios is possible.
- CPU Pool Usage: monthly average history of CPU usage of each system. Based on last 12 months of lslparutil data.
- Sys RAM Usage: monthly average history of physical memory assignement to each LPAR. Based on last 12 months of lslparutil data.
- LPAR CPU Usage:monthly average history of CPU usage of each LPAR. Based on last 12 months of lslparutil data.
- **CPU Pool Daily Usage**: 1 year of CPU usage of every pool and subpools of each system. Based on daily averages.
- **LPAR Daily Usage**: 1 year of CPU usage of every LPAR of each system. Based on daily averages.
- **CPU Pool HourlyUsage**: 2 months of CPU usage of every pool and subpools of each system. Based on hourly averages.
- **LPAR Hourly Usage**: 2 months of CPU usage of every LPAR of each system. Based on hourly averages.

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RUNNING HMC SCANNER

I run it from AIX as Windows and Java issues have caused problems

Right now I have HMCScanner11
./hmcScanner.ksh *hmcname* hscroot -p *password* –stats

```
hmcScanner version 0.11.0
Detecting manager type: HMC
Detecting managed systems: 3 systems present.
Starting managed system configuration collection:
  Scanning p720-Server-8202-E4B-SN10934BP: ..... DONE
  Scanning p740-Server-8205-E6B-SN10934CP: ..... DONE
  Scanning p750-Server-8233-E8B-SN069348P: ..... DONE
Collection successfully finished. Data is in /software/hmcscanner-11/bpichmc/
Performance data collection:
  Loading p720-Server-8202-E4B-SN10934BP: . .
  Loading p740-Server-8205-E6B-SN10934CP: . .
  Loading p750-Server-8233-E8B-SN069348P: . .
..... DONE
```

bpichmc_20140722_111805_scan.xls
bpic8hmc_20140722_104308_scan.xls

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VIOS ADVISOR

https://www.ibm.com/developerworks/community/wikis/home/wiki/Power%20Systems/page/VIOS%20Advisor

Application that collects performance metrics and does a health check
Productized in VIOS 2.2.2
Current downloadable version is 030813A
Examples follow

- These were run on a production VIO during a regular production day

Duration is between 10 and 60 minutes. Samples collected every 15 seconds
To run for 10 minutes:
$ part -i 10

Creates a tar file
The report to read is the vios_advisor_report.xml report

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VIOS ADVISOR

$ part -i 10
part: Reports are successfully generated in b740vio2_140722_19_46_12.tar

$oem_setup_env
#tar –tvf b740vio2_ .tar
pwd
/home/padmin/jaqui/b740vio2_140722_19_46_12
ls -l
total 704
-rw-r--r-- 1 root staff 249619 Jul 22 19:56 b740vio2_140722_1946.nmon
drwxr-xr-x 2 padmin staff 4096 Jul 22 19:56 images
-r--r--r-- 1 padmin staff 8122 Jul 22 19:56 popup.js
-r--r--r-- 1 padmin staff 6971 Jul 22 19:56 style.css
-r--r--r-- 1 padmin staff 16869 Jul 22 19:56 vios_advisor.xsl
-rw-r--r-- 1 padmin staff 32677 Jul 22 19:56 vios_advisor_report.xml
-r--r--r-- 1 padmin staff 29156 Jul 22 19:56 vios_advisorv2.xsl

Can also process nmon files:
$ part -f b750vio1_140721_2359.nmon
part: Reports are successfully generated in b750vio1_140721_2359.tar

tar -tvf b750vio1_140721_2359.tar
-r--r--r-- 10 1 16869 Jul 22 19:48:10 2014 ./b750vio1_140721_2359/vios_advisor.xsl
-rw-r--r-- 10 1 36446 Jul 22 19:48:09 2014 ./b750vio1_140721_2359/vios_advisor_report.xml
-r--r--r-- 10 1 29156 Jul 22 19:48:10 2014 ./b750vio1_140721_2359/vios_advisorv2.xsl

b750vio1_140721_2359\vios_advisor_report.xml

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The ratings and recommendations in the table below were chosen with the following information:

Hostname : vio1. .com
PartitionID: 2
Monitoring Start Time : 03/09 11:45:19
Monitoring Stop Time : 03/09 13:45:19 **Duration :** 120 min
IBM Systems Workload Estimator link: http://ibm.com/systems/support/tools/estimator *(VIOS Sizings)*

SYSTEM - CONFIGURATION	
Name	**Value**
Processor Family	POWER6
Server Model	IBM,9117-MMA
Server Frequency	4.208 GHz
Server - Online CPUs	10 cores
Server - Maximum Supported CPUs	16 cores
VIOS Level	2.2.0.13-FP24 SP-03
VIOS Advisor Release	121211B

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VIOS - CPU

Name	Measured Value	Recommended Value	First Observed	Last Observed	Risk 1=lowest 5=highest	Impact 1=lowes 5=highes
CPU Capacity	1.0 ent	-	03/09 11:45:19	-	n/a	n/a
CPU Consumption	avg:5.4% (cores:0.1) high:40.2% (cores:0.5)	-	-	-	n/a	n/a
Processing Mode	Shared CPU, (UnCapped)	-	03/09 11:45:19	-	n/a	n/a
Variable Capacity Weight	200	-	03/09 11:45:19	-	n/a	n/a
Virtual Processors	2 vCPUs	-	03/09 11:45:19	-	n/a	n/a
SMT Mode	SMT2	-	03/09 11:45:19	-	n/a	n/a

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SYSTEM - SHARED PROCESSING POOL

Name	Measured Value	Recommended Value	First Observed	Last Observed	Risk 1=lowest 5=highest	Impact 1=lowes 5=highes
Shared Pool Monitoring	enabled	-	03/09 11:45:19	-	n/a	n/a
Shared Processing Pool Capacity	10.0 ent.	-	03/09 11:45:19	-	n/a	n/a
Free CPU Capacity	avg_free:9.4 ent. lowest_free:7.7 ent.	-	-	-	n/a	n/a

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VIOS - I/O ACTIVITY

Name	Value
Disk I/O Activity	avg: 229 iops @ 32KB peak: 1916 iops @ 137KB
Network I/O Activity	[avgSend: 0 iops 0.0MBps , avgRcv: 0 iops 0.0MBps] [peakSend: 0 iops 0.0MBps , peakRcv: 0 iops 0.0MBps]

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VIOS - DISK ADAPTERS

Name	Measured Value	Recommended Value	First Observed	Last Observed	Risk 1=lowest 5=highest	Impact 1=lowest 5=highest
FC Adapter Count	3	-	03/09 11:45:19	-	n/a	n/a
FC Avg IOps	avg: 77 iops @ 32KB	-	03/09 11:45:19	03/09 13:45:19	n/a	n/a
FC Adapter Utilization	optimal	-	-	-	n/a	n/a
FC Port Speeds	running at speed	-	-	-	n/a	n/a

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VIOS - DISK DRIVES

Name	Measured Value	Recommended Value	First Observed	Last Observed	Risk 1=lowest 5=highest	Impact 1=lowest 5=highest
Physical Drive Count	93	-	03/09 11:45:19	-	n/a	n/a
I/Os Blocked	optimal	-	-	-	n/a	n/a
Long I/O Latency (hdisk3)	avg:9.7ms (9.7 + 0.0) high:11.5ms (11.5 + 0.0)	Range: 8-12ms	03/09 12:35:58	03/09 13:44:02	n/a	n/a

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VIOS - MEMORY

Name	Measured Value	Recommended Value	First Observed	Last Observed	Risk 1=lowest 5=highest	Impact 1=lowest 5=highest
Real Memory	4.000 GB	7.000 GB	03/09 11:45:19	-	1	2
Available Memory	0.346 GB	1.5 GB Avail.	03/09 11:45:39	03/09 13:45:05	n/a	n/a
Paging Rate	0.2 MB/s pg rate	-	-	-	n/a	n/a
Paging Space Size	8.000 GB	-	03/09 11:45:19	-	n/a	n/a
Free Paging Space	7.923 GB free	-	-	-	n/a	n/a
Pinned Memory	1.262 GB pinned	-	-	-	n/a	n/a

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SSP LIMITATIONS

http://www14.software.ibm.com/webapp/set2/sas/f/vios/vios2233.readme.html

Limitations for Shared Storage Pool
Software Installation
•All VIOS nodes must be at version 2.2.1.3 or later.
•When installing updates for VIOS Update Release 2.2.3.3 participating in a Shared Storage Pool, the Shared Storage Pool Services must be stopped on the node being upgraded.
SSP Configuration

Feature	Min	Max
Number of VIOS Nodes in Cluster	1	16
Number of Physical Disks in Pool	1	1024
Number of Virtual Disks (LUs) Mappings in Pool	1	8192
Number of Client LPARs per VIOS node	1	200
Capacity of Physical Disks in Pool	10GB	16TB
Storage Capacity of Storage Pool	10GB	512TB
Capacity of a Virtual Disk (LU) in Pool	1GB	4TB
Number of Repository Disks	1	1
Capacity of Repository Disk	512MB	1016GB

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REFERENCES

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USEFUL LINKS

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Andrew Goade Articles
- http://www.ibmsystemsmag.com/authors/Andrew-Goade/

Jaqui Lynch Articles
- http://www.ibmsystemsmag.com/authors/Jaqui-Lynch/
- https://enterprisesystemsmedia.com/author/jaqui-lynch

Jay Kruemke Twitter – chromeaix
- https://twitter.com/chromeaix

Nigel Griffiths Twitter – mr_nmon
- https://twitter.com/mr_nmon

Gareth Coates Twitter – power_gaz
- https://twitter.com/power_gaz

Jaqui's Upcoming Talks and Movies
- Upcoming Talks
  - http://www.circle4.com/forsythetalks.html
- Movie replays
  - http://www.circle4.com/movies

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USEFUL LINKS

Nigel Griffiths
- AIXpert Blog
  - https://www.ibm.com/developerworks/mydeveloperworks/blogs/aixpert/?lang=en
- 10 Golden rules for rPerf Sizing
  - https://www.ibm.com/developerworks/mydeveloperworks/blogs/aixpert/entry/size_with_rperf_if_you_must_but_don_t_forget_the_assumptions98?lang=en
- Youtube channel
  - http://www.youtube.com/user/nigelargriffiths

AIX Wiki
- https://www.ibm.com/developerworks/wikis/display/WikiPtype/AIX

HMC Scanner
- http://www.ibm.com/developerworks/wikis/display/WikiPtype/HMC+Scanner

Workload Estimator
- http://ibm.com/systems/support/tools/estimator

Performance Tools Wiki
- http://www.ibm.com/developerworks/wikis/display/WikiPtype/Performance+Monitoring+Tools

Performance Monitoring
- https://www.ibm.com/developerworks/wikis/display/WikiPtype/Performance+Monitoring+Documentation

Other Performance Tools
- https://www.ibm.com/developerworks/wikis/display/WikiPtype/Other+Performance+Tools
- Includes new advisors for Java, VIOS, Virtualization

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SG24-8080 – Power Systems Performance Guide – Implementing and Optimizing
- http://www.redbooks.ibm.com/redbooks/pdfs/sg248080.pdf

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- http://www.redbooks.ibm.com/redbooks/pdfs/sg248079.pdf

Redbook Tip on Maximizing the Value of P7 and P7+ through Tuning and Optimization
- http://www.redbooks.ibm.com/technotes/tips0956.pdf

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VIOS SPECIFIC REFERENCES

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- http://www-01.ibm.com/support/docview.wss?uid=ssg1S7002686&aid=1

VOS 2.2.3.3 README
- http://www14.software.ibm.com/webapp/set2/sas/f/vios/vios2233.readme.html

SG24-7940 - PowerVM Virtualization - Introduction and Configuration
- http://www.redbooks.ibm.com/redbooks/pdfs/sg247940.pdf

SG24-7590 – PowerVM Virtualization – Managing and Monitoring
- http://www.redbooks.ibm.com/redbooks/pdfs/sg247590.pdf

SG24-8080 – Power Systems Performance Guide – Implementing and Optimizing
- http://www.redbooks.ibm.com/redbooks/pdfs/sg248080.pdf

SG24-8079 – Power 7 and 7+ Optimization and Tuning Guide
- http://www.redbooks.ibm.com/redbooks/pdfs/sg248079.pdf

Redbook Tip on Maximizing the Value of P7 and P7+ through Tuning and Optimization
- http://www.redbooks.ibm.com/technotes/tips0956.pdf

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THANK YOU FOR YOUR TIME

If you have questions please email me at:
lynchj@forsythe.com

Handouts will be at:
http://www.circle4.com/papers/viosmaint.pdf

Replay will be at:
http://www.circle4.com/movies/

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